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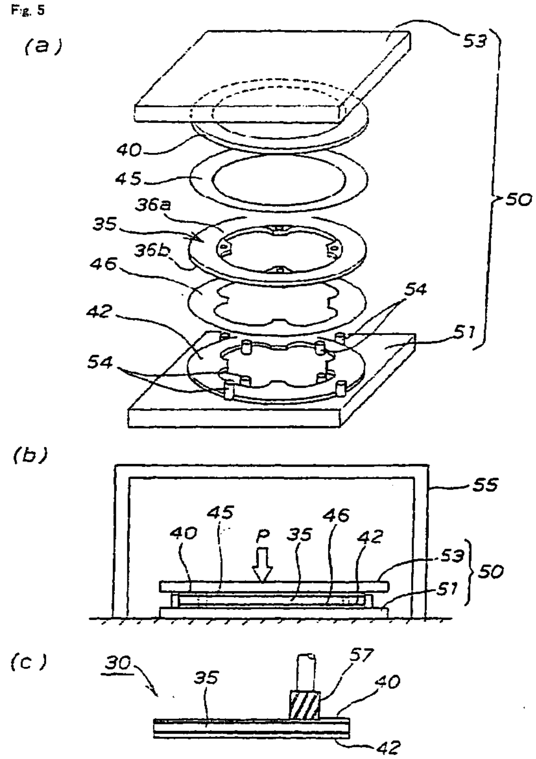
(54) Brake disk composed from different metals and method for manufacturing the same

(57) The invention provides techniques capable of forming a light brake disk and of suppressing the cost of the brake disk

A brake disk (30) has a disk body (35) formed of a titanium alloy, and inner and outer friction members (40, 42) formed of a stainless steel and bonded to the opposite surfaces (36a, 36b) of the disk body (35) by a brazing method. The friction members (40, 42) can be simply bonded to the opposite surfaces (36a, 36b) of the disk body (35).

Fig. 5



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Description

[0001] The present invention relates to a brake disk against which brake pads are pressed for braking.

[0002] A disk brake for a motorcycle has a brake disk and brake pads which are pressed against the opposite surfaces (friction members) of the brake disk for braking. Some lightweight brake disk has a disk body formed of a lightweight material, and friction members of a highly frictional material are attached to the opposite surfaces of the disk body.

[0003] A disk brake disclosed in, for example, JP-A No. H8-226478 has a lightweight brake disk. This technique forms friction parts by fixing frictional material to the opposite surfaces of the disk body of the brake disk. The formation of the friction parts of the frictional material enables the formation of the lightweight brake disk of a light aluminum alloy.

The present invention forms friction parts by attaching a frictional material to a brake disk by spraying or application. The thickness of the friction parts is in the range of about 10 to about 20 μm.

Some type of brake disks need friction parts of a greater thickness.

[0004] A brake disk provided with thick frictional members is disclosed in, for example, JP-A No. H9-42339. This technique bonds friction members of an alloy steel to the opposite surfaces of an aluminum disk by explosive cladding.

An explosive cladding method has troublesome steps of putting an alloy steel member on an aluminum member, mounting a buffer on the alloy steel member, putting a proper amount of explosive on the buffer, and detonating the explosive by a detonator attached to one end of the explosive. Thus, the explosive cladding method is costly.

[0005] A disk rotor disclosed in Japanese Utility Model No. 2557898 is a brake disk provided with a thick frictional member. This technique places a plate-shaped member of a carbon-fiber-reinforced composite material between a pair of metal plates forming a disk rotor, and joins together the pair of metal plates and the plate-shaped member by riveting.

A process for uniting together the pair of metal plates and the plate-shaped member needs a step of forming a plurality of through holes in the pair of metal plates and the plate-shaped member and a step of pressing down the ends of a plurality of rivets. Thus, this technique needs many parts, which increases the cost.

[0006] Thus, the prior art are not practically suitable for mass production in which a member formed of a titanium alloy or an aluminum alloy and member formed of an iron-base material are bonded together.

An explosive cladding method proposed in JP-A No. H9-42339 and a rivet bonding method disclosed in Japanese Utility Model No. 2557898 increase the manufacturing cost of the brake disk. Manufacturing techniques that replace the know techniques have been desired.

[0007] Accordingly, it is an object of the present invention to provide techniques capable of reducing the weight of a brake disk by bonding together a member of a titanium alloy or an aluminum alloy and a member formed of an iron-base member and of suppressing cost.

[0008] To achieve the object, a brake disk stated in a first aspect of the invention comprises a disk body formed of a titanium alloy or an aluminum alloy, and friction members formed of an iron-base material and bonded to the opposite surfaces of the disk body by brazing.

[0009] There has not been any practical technique suitable for mass production in which a member of a light titanium alloy or aluminum alloy having a high strength and a member of an iron-base material. According to the present invention, the disk body is formed of a light titanium alloy or aluminum alloy having a high strength, and friction members formed of an iron-base material are bonded together by brazing. The use of a light titanium alloy or aluminum alloys having a high strength reduces the weight of the brake disk.

The friction members are bonded to the disk body by brazing. The friction members can be bonded to the disk body simply by forming a brazing filler metal layer between each of the friction members and the disk body and melting the brazing filler metal layer.

[0010] A brake disk stated in a second aspect of the invention for a motorcycle, to be mounted on a hub included in a wheel comprises a disk body formed of a titanium alloy or an aluminum alloy, and friction members formed of an iron-base material and bonded to the opposite surfaces of the disk body by brazing; wherein the pair of friction members have different thicknesses, respectively.

[0011] The disk body is formed of a titanium alloy or an aluminum alloy, and the friction members formed of an iron-base material are bonded to the opposite surfaces of the disk body by brazing.
The titanium alloy or the aluminum alloy is light and has a high strength and enables the reduction of the weight of the brake disk without deteriorating the braking ability of the brake disk.

The friction members are bonded to the disk body by a brazing method. The friction members can be bonded to the disk body simply by forming a brazing filler metal layer between each of the friction members and the disk body and melting the brazing filler metal layer.

[0012] As generally known, when a brake disk is incorporated into a motorcycle, the outer surface of the brake disk opposite the inner surface of the same facing the wheel of the motorcycle is exposed more efficiently to running wind than the inner surface. Therefore, when a braking force is exerted on the brake disk, the inner friction member facing the wheel is heated at a temperature higher than that at which the outer friction member is heated. Friction coefficient

between the friction member and a brake pad decreases as the temperature of the friction member rises. Therefore, it is important to maintain the friction members at a fixed temperature.

[0013] To realize this, the pair of friction members are formed in different thicknesses, respectively, and, for example, the brake disk is incorporated into a motorcycle so that the thicker friction member is on the inner surface and faces the wheel and the thinner friction member is on the outer surface and is exposed more efficiently to running wind. The thicker friction member is capable of absorbing a large amount of heat generated when a braking force is applied to the brake disk. Thus, the inner friction member facing the wheel and the outer friction member not facing the wheel are maintained at the same temperature.

[0014] Consequently, both the friction coefficient associated with the inner friction member and the friction coefficient associated with the outer friction member can be held on a substantially fixed level.

[0015] A preferred embodiment of the present invention will be described with reference to the accompanying drawings.

[0016] Fig. 1 is a side elevation of a motorcycle employing a brake disk in a first embodiment according to the present invention.

[0017] Fig. 2 is a sectional view taken on line 2-2 in Fig. 1.

[0018] Fig. 3 is a sectional view of the brake disk in the first embodiment.

[0019] Fig. 4 is a plan view of the brake disk in the first embodiment.

[0020] Fig. 5 is a view of assistance in explaining a brazing method to be carried out when fabricating the brake disk in the first embodiment.

[0021] Fig. 6 is a graph showing the variation of the friction coefficient associated with the friction member of a brake disk in a second embodiment according to the present invention with the temperature of the same.

[0022] Fig. 7 is a sectional view of a brake disk in a third embodiment according to the present invention.

[0023] Fig. 8 is a graph showing the relation between friction coefficient associated with the brake disk in the third embodiment and the thickness of friction members.

[0024] In the following description, words "front", "back", "right" and "left" signify directions with respect to a rider, and the drawings are supposed to be viewed with the reference characters in an erect position.

Amotorcycle 10 has a body frame 11, a front fork 12 supported in a head pipe 11a included in the body frame 11, a handlebar 13 attached to the upper end of the front fork 12, a front wheel 14 attached to the lower end of the front fork 12, a fuel tank 15 mounted on a front part of the body frame 11, a seat 16 mounted on a part of the body frame behind the fuel tank 15, a power unit 17 (formed by combining an engine 17a and a transmission 17b) disposed under and attached to a front part of the body frame 11, swing arms 18 pivotally joined for swinging to a rear part of the body frame 11, and a rear wheel 19 supported on a rear end part of the swing arm 18 and provided with a brake disk 30 in a preferred embodiment according to the present invention. The brake disk 30 of the present invention will be described hereinafter.

[0025] Fig. 2 is a sectional view taken on line 2-2 in Fig. 1. A wheel 20 comprises a hub 21, a spoke 22 and a rim 23. The wheel 20 is disposed between the swing arms 18 and is supported for rotation by a rear axle 24 attached to the swing arms 18. A tire 25 is fitted on the rim 23. A sprocket 26 is fastened to the right side surface of the hub 21 with bolts 27 and a drive chain, not shown, is wound round the sprocket 26. The brake disk 30 is fastened to the left side surface of the hub 21 with bolts 31 and a caliper 32 is combined with a lower part of the brake disk 30.

[0026] The caliper 32 is attached to the body of the motorcycle 10 (Fig. 1). Brake pads 33 are held on the caliper 32 so as to face an inner friction member 40 and an outer friction member 42 of the brake disk 30, respectively.

The calipers 33 held on the caliper 32 are pressed against the inner friction member 40 and the outer friction member 42, respectively, to exert a braking force to the brake disk 30.

[0027] Fig. 3 is a sectional view of a brake disk in a first embodiment according to the present invention.

The brake disk 30 has a disk body 35 formed of a titanium alloy, an inner friction member 40 formed of a stainless steel and bonded by brazing to the inner surface 36a, i.e., a surface facing the wheel 20, of the brake disk 35, and an outer friction member 42 formed of a stainless steel and bonded by brazing to the outer surface 36b, i.e., a surface not facing the wheel 20.

[0028] The disk body 35 has an annular part 36 of a thickness tl and mounting lugs 37 of a thickness t2 provided with a through hole 37a and formed integrally with the annular part 36 so as to project radially inward from the inner circumference of the annular part 36. The disk body 35 is formed of a titanium alloy and is provided with a recess in the inner surface 36a facing the wheel 20. Although it is preferable that the titanium alloy contains 6% aluminum and 4% vanadium, the titanium alloy may be of any other composition.

The inner friction member 40 is bonded to the inner surface 36a facing the wheel 20 of the annular part 36 with a brazing filler metal layer 45, and the outer friction member 42 is bonded to the outer surface 36b of the same with a brazing filler metal layer 46. The surface of the outer friction member 42 is flush with the outer surface of the disk body 35.

[0029] The inner friction member 40 is formed of a stainless steel, such as SUS410M, JIS, in a shape substantially the same as that of the inner surface 36a of the annular part 36. Preferably, the thickness t3 of the inner friction member

40 is in the range of 0.3 to 0.5 mm, but the thickness is not limited thereto.

The outer friction member 42 is formed of a stainless steel, such as SUS410M, JIS, in a shape substantially the same as that of the outer surface 36b of the disk body 35. Preferably the thickness t4 of the outer friction member 42, similarly to that of the inner friction member 40, in the range of 0.3 to 0.5 mm, but the thickness is not limited thereto.

Preferably, the inner brazing filler metal sheet 45 and the outer brazing filler metal sheet 46 are formed of an activated silver solder containing 70% silver, 28%copper and 2% titanium. However the inner brazing filler metal sheet 45 and the outer brazing filler metal sheet 46 may be formed of any suitable material other than the activated silver solder.

[0030] Fig. 4 is a plan view of the brake disk 30 in the first embodiment as viewed from the side of the wheel 19 (Fig. 2). The annular inner friction member 40 is bonded to the inner surface 36a (Fig. 3) of the disk body 35 by brazing, and the annular outer friction member 42 is bonded to the outer surface 36b (Fig. 3) by brazing to form the brake disk 30.

Bolts 31 are passed through the through holes 37a of the brake disk 30 and are screwed in threaded holes formed in the hub 21 to fasten the brake disk 30 to the hub 21.

[0031] The relation between the friction coefficient associated with the brake disk 30 and the weight of the brake disk 30 will be described with reference to Table 1.

Table 1

	Material	Friction coefficient (μ)	Weight
Comparative example 1	Stainless steel	0.5	w
Comparative example 2	Titanium alloy	0.2-0.7	0.6w
Comparative example 3	Aluminum alloy	0.3	0.3w
Example	Titanium alloy and stainless steel	0.5	0.7w

[0032] A brake disk in Comparative example 1 is formed of a stainless steel, a brake disk in Comparative example 2 is formed of a titanium alloy, a brake disk in Comparative example 3 is formed of an aluminum alloy, and the brake disk in the first embodiment is a brake disk in Example.

The weight of each brake disk is represented by a multiple of the weight W of the brake disk in Comparative example 1.

[0033] Friction coefficient associated with Comparative example 1 is 0.5 and Comparative example 1 has a weight of W. The friction coefficient is sufficiently large but the weight is large.

Friction coefficient associated with Comparative example 2 varies in the range of 0.2 to 0.7 and Comparative example 2 has a weight of 0.6W. The weight is small enough, but the friction coefficient varies and it is difficult to produce stable braking force.

Friction coefficient associated with Comparative example 3 is 0.3 and Comparative example 3 has a weight of 0.3W. The weight, similarly to that of the Comparative example 2, is small enough, but the friction coefficient is small and it is difficult to produce sufficient braking force.

Friction coefficient associated with Example is 0.5 and Example has a weight of 0.7W. The friction coefficient is large enough and the weight is satisfactorily small.

[0034] The brake disk in the first embodiment has the disk body 35 formed of the light titanium alloy having a high strength, and the friction members 40 and 42 respectively formed of the different iron-base materials are bonded to the opposite surfaces of the disk body 35 by brazing. Thus, the bonding of members of different materials by brazing enables the use of the light titanium alloy having a high strength for forming the disk body 35, which enables the brake disk 30 to be formed in a lightweight structure.

[0035] A brazing method employed in fabricating the brake disk 30 will be described.

Figs. 5(a) to 5(c) illustrate a brazing method employed in fabricating the brake disk 30 in the first embodiment.

In a step shown in Fig. 5(a), a brazing jig 50 having a support plate 51 and a pressure plate 53 is prepared, the outer friction member 42 is located between a plurality of pins 54 attached to the support plate 51, and an outer brazing filler metal sheet 46, the disk body 35, an inner brazing filler metal sheet 45 and the inner friction member 40 are superposed in that order on the outer friction member 42. Then, the pressure plate 53 is placed on the inner friction member 40.

[0036] Preferably, the thickness of workpieces for forming the inner friction member 40 and the outer friction member 42 is slightly greater than a desired thickness of the inner friction member 40 and the outer friction member 42 in the range of 0.3 to 0.5 mm to provide the workpieces with a grinding allowance.

Preferably, the inner brazing filler metal sheet 45 has a shape similar to that of the inner friction member 40 and a thickness of 100 μm, but the shape and the thickness of the inner brazing filler metal sheet 45 are not limited thereto.

Preferably, the outer brazing filler metal sheet 46 has a shape similar to that of the outer friction member 42 and a thickness of 100 μm, but the shape and the thickness of the inner brazing filler metal sheet 46 are not limited thereto.

The inner brazing filler metal sheet 45 and the outer brazing filler metal sheet 46 may be substituted by powder.

[0037] In a step shown in Fig. 5 (b), the jig 50 holding the outer friction member 42, the outer brazing filler metal sheet 46, the disk body 35, the inner brazing filler metal sheet 45 and the inner friction member 40 is placed in a vacuum vessel 55, a load P of about 2 kg is applied in the direction of the blank arrow to the pressure plate 53 to apply a pressure of 0.01 kgf/cm^2 to surfaces to be bonded together by brazing.

[0038] Subsequently, the vacuum vessel 55 is evacuated to a vacuum of 1.5 torr, and then the interior atmosphere of the vacuum vessel 55 is heated at 850 °C for 40 min to melt the inner brazing filler metal sheet 45 and the outer brazing filler metal sheet 46. Consequently, the inner friction member 40 is bonded to the inner surface 36a of the disk body 35 by the molten inner brazing filler metal sheet 45 and the outer friction member 42 is bonded to the outer surface 36b (Fig. 3) of the disk body 35 by the molten outer brazing filler metal sheet 46.

[0039] The brazing method loads the pressure plate 53 with the load P of about 2 kg to prevent the deformation of the inner friction member 40 and the outer friction member 42.

The outer friction member 42, the outer brazing filler metal sheet 46, the disk body 35, the inner brazing filler metal sheet 45 and the inner friction member 40 are located by the pins 54 to prevent the dislocation of those members during brazing.

[0040] The brazing method is able to bond together members of different materials, such as a member of a titanium alloy and a member of an iron-base material. Thus, the disk body 35 can be formed by a light titanium alloy having a high strength, which is effective in reducing the weight of the brake disk 30.

[0041] In a step shown in Fig. 5(c), the surfaces of the inner friction member 40 and the outer friction member 42 bonded to the disk body 35 are machined with a cutting tool 57 to finish the surfaces of the inner friction member 40 and the outer friction member 42 in a flatness required of the brake disk 30 . Preferably, the thickness of the thus finished friction members 40 and 42 is in the range of 0.3 to 0.5 mm.

If the surfaces of the inner friction member 40 and the outer friction member 42 as bonded to the disk body 35 have a flatness required of the brake disk 30, the same surfaces do not need to be finished by machining.

[0042] In the first embodiment, the friction members 40 and 42 are bonded to the disk body 35 by the brazing method. The friction members 40 and 42 can be easily bonded to the disk body 35 simply by spreading a brazing filler metal between the friction members 40 and 42, and the disk body 35 and melting the brazing filler metal.

[0043] A brake disk in a second embodiment according to the present invention will be described hereinafter.

The brake disk in the second embodiment has a disk body formed of an aluminum alloy, and friction members formed of a stainless steel and bonded to the disk body by brazing. Thus, the brake disk in the second embodiment is the same as the brake disk 30 in the first embodiment except that the former has the disk body formed of the aluminum alloy.

[0044] Fig. 6 is a graph showing the variation of the friction coefficient associated with the friction member of the brake disk in the second embodiment with the temperature of the same, in which friction coefficient associated with the friction member is measured on the vertical axis, the temperature of the friction member is measured on the horizontal axis, a solid circle is for a brake disk in Comparative example and a blank circle is for the brake disk in Example. The brake disk in Comparative example has a disk body integrally provided with friction parts and formed of a stainless steel. The brake disk in Example is the brake disk in the second embodiment.

The stainless steel has a heat transfer coefficient of about 0.18 cal/cm · s · °Cand the aluminum alloy has a heat transfer coefficient of bout 0.53 cal/cm · s · °C. Thus, the heat transfer coefficient of the aluminum alloy is as great as about three times that of the stainless steel.

The temperature of the friction member and the friction coefficient associated with the friction member were measured by rotating the brake disk at a predetermined rotating speed, and pressing brake pads against the rotating brake disk for braking.

[0045] Heat generated in the friction member of the brake disk in Comparative example by a braking action cannot be transferred at a high rate to the disk body. Therefore, if the braking action continues for a long time, the temperature of the friction member rises and the friction coefficient decreases slightly as indicated by a solid circle. Although this brake disk in Comparative example is satisfactory in braking effect, a further effective braking disk has been desired.

[0046] Since the disk body of the brake disk in the second embodiment is formed of the aluminum alloy, heat generated in the friction member during braking can be satisfactorily absorbed by the disk body. Therefore, even if large braking energy is produced, the rise of the temperature of the friction member can be suppressed as indicated by a blank circle. Consequently, the friction coefficient remains substantially constant and a sufficient braking force can be produced.

Moreover, the brake disk in the second embodiment, similarly to that in the first embodiment, can be formed in a lightweight structure, which is effective in improving the performance of the motorcycle.

[0047] A brake disk in a third embodiment according to the present invention will be described with reference to Fig.

7 showing the brake disk in a sectional view of, in which parts like or corresponding to those of the brake disk in the first embodiment are denoted by the same reference characters and the description thereof will be omitted.

A brake disk 60 has a disk body 35 formed of a titanium alloy, an inner friction member 62 and an outer friction member 64. The inner friction member 62 and the outer friction member 64 are bonded to the inner surface 36a of the disk body 35 on the side of a wheel and an outer surface 36b of the disk body 35 opposite the inner surface 36a, respectively, by brazing.

[0048] The inner friction member 62 is bonded to the inner surface 36a of an annular part 36 by an inner brazing filler meal layer 45 and the outer friction member 64 is bonded to the outer surface 36b of the annular part 36 by an outer brazing filler meal layer 46. The surface of the outer friction member 64 is flush with the surface of the outer surface of the disk body 35.

[0049] The inner friction member 62 is formed of a stainless steel, such as SUS410M, JIS, in a shape substantially the same as that of the inner surface 36a of the annular part 36. Preferably, the thickness t5 of the inner friction member 62 is in the range of 0.3 to 0.5 mm, but the thickness is not limited thereto.

The outer friction member 64 is formed of a stainless steel, such as SUS410M, JIS, in a shape substantially the same as that of the outer surface 36b of the disk body 35. Preferably, the thickness t6 of the outer friction member 64 is, similarly to that of the inner friction member 62, in the range of 0.3 to 0.5 mm, but the same thickness is not limited thereto.

[0050] The thickness t5 of the inner friction member 62 of the brake disk 60 is greater than the thickness t6 of the outer friction member 64 of the brake disk 60, i.e., the inner friction member 62 and the outer friction member 64 have different thicknesses, respectively. The brake disk 60 is attached to the hub 21 of the wheel 19 of the motorcycle 10 shown in Fig. 1 with the thicker friction member 62 facing the wheel 19 and the thinner friction member 64 faced outward so as to be exposed to running wind more efficiently than the former.

The inner friction member 62 and the outer friction member 64 are the same in construction as the inner friction member 40 and the outer friction member 42 of the first embodiment, respectively, except that the inner friction member 62 and the outer friction member 64 have the different thicknesses t5 and t6, respectively.

[0051] As generally known, when the brake disk 60 is incorporated into the motorcycle 10 shown in Fig. 1, the outer surface of the brake disk 60, i.e., the outer friction member 64, is exposed more efficiently to running wind than the inner surface of the same, i.e., the inner friction member 62.

Therefore, when a braking force is exerted on the brake disk 60, the inner friction member 62 is heated at a temperature higher than that at which the outer friction member 64 is heated. Friction coefficients associated with the inner friction member 62 and the outer friction member 64 decrease as the temperatures of the inner friction member 62 and the outer friction member 64 rise. Therefore, it is important to maintain the friction members at a fixed temperature.

[0052] To realize this, the inner friction member 62 is formed in the thickness t5 greater than the thickness t6 of the outer friction member 64. The thicker inner friction member 62 is capable of absorbing a large amount of heat generated when a braking force is applied to the brake disk 60. Thus, the inner friction member 62 and the outer friction member 64 can be maintained at substantially the same temperature even though the inner friction member 62 is exposed to running wind less efficiently than the outer friction member 64. Consequently, both the friction coefficient associated with the inner friction member 62 and the friction coefficient associated with the outer friction member 64 can be held on a substantially fixed level and substantially the same braking force can be produced on the opposite sides of the brake disk 60.

[0053] Influence of the thickness of the friction member on friction coefficient will be explained with reference to Figs. 7 and 8.

Fig. 8 is a graph showing the relation between friction coefficient associated with the brake disk in the third embodiment and the thickness of the friction members, in which the mean of the friction coefficients respectively associated with the friction members 62 and 64 is measured on the vertical axis and the thickness ratio t5/t6, i.e., the ratio of the thickness t5 of the inner friction member 62 to the thickness t6 of the outer friction member 64, is measured on the horizontal axis. Friction coefficients were measured under measuring conditions that are more severe than those for the measurement of the friction coefficients shown in Table 1 associated with the brake disks in the first embodiment and those in the comparative examples to elucidate the effect of the difference in thickness between the inner and the outer friction member on the difference in friction coefficient. Therefore, the values of the friction coefficients are different from those shown in Table 1.

[0054] Friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.41 when the thickness ratio t5/t6 is 0.25, i.e., when the thickness t5 of the inner friction member 62 is 1/4 of the thickness t6 of the outer friction member 64. Friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.43 when the thickness ratio t5/t6 is 0.5, i.e., when the thickness t5 of the inner friction member 62 is 1/2 of the thickness t6 of the outer friction member 64. Friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.46 when the thickness ratio t5/t6 is 0.75, i.e., when the thickness t5 of the inner friction member

62 is 3/4 of the thickness t6 of the outer friction member 64.

[0055] Friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.48 when the thickness ratio t5/t6 is 1.0, i.e., when the thickness t5 of the inner friction member 62 is equal to the thickness t6 of the outer friction member 64. Friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.49 when the thickness ratio t5/t6 is 1.25, i.e., when the thickness t5 of the inner friction member 62 is 1.25 times the thickness t6 of the outer friction member 64. Friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.5 when the thickness ratio t5/t6 is 1.5, i.e., when the thickness t5 of the inner friction member 62 is 1.5 times the thickness t6 of the outer friction member 64.

[0056] As obvious from the graph shown in Fig. 8, friction coefficients respectively associated with the opposite surfaces of the brake disk are 0.46, which are fairly satisfactory, when the thickness t5 of the inner friction member 62 is equal to the thickness t6 of the outer friction member 64.

[0057] Friction coefficients respectively associated with the opposite surfaces of the brake disk can be increased beyond 0.46 when the thickness t5 of the inner friction member 62 is greater than the thickness t6 of the outer friction member 64.

Particularly, when the thickness t5 of the inner friction member 62 is 1.t times the thickness 5t of the outer friction member 64, friction coefficients associated with the opposite surfaces of the brake disk is as large as 0.5.

[0058] The respective disk bodies of the brake disks in the first and the third embodiment are formed of the titanium alloy; those disk bodies may be formed of a light material having a high rigidity other than the titanium alloy, such as titanium, aluminum, an aluminum alloy or the like.

The disk body of the brake disk in the second embodiment is formed of an aluminum alloy; this disk body may be formed of a material having a large heat transfer coefficient, such as aluminum.

Although the friction members of the foregoing embodiments are formed of the stainless steel, the same may be formed of an iron-base material other than the stainless steel, such as a carbon steel or cast iron, provided that the iron-base material is capable of forming friction members having a frictional property represented by a satisfactory friction coefficient.

[0059] In the third embodiment, the inner friction member 62 facing the wheel is thick and the outer friction member 64 not facing the wheel is thin. The inner friction member 62 may be thin and the outer friction member 64 may be thick.

[0060] The present invention exercises the following effects.

In the brake disk stated in the first aspect, the disk body is formed of the titanium alloy or the aluminum alloy, and the friction members formed of the iron-base material are bonded to the opposite surfaces of the disk body by brazing. The disk body formed of the light titanium alloy or aluminum alloy reduces the weight of the brake disk.

The friction members are bonded to the disk body by the brazing method. The disk body is formed of the titanium alloy or the aluminum alloy, the friction members are formed of the iron-base material, and the brazing filler metal is sandwiched between the disk body and the friction members, which are formed of different materials, respectively, and the friction members can be bonded to the disk body simply by melting the brazing filler metal, which reduces the cost of the brake disk.

[0061] In the brake disk stated in the second aspect, the disk body is formed of the titanium alloy or the aluminum alloy, and the friction members formed of the iron-base material are bonded to the opposite surfaces of the disk body by brazing. The titanium alloy or the aluminum alloy is a light material having a high strength and reduces the weight of the brake disk.

[0062] Moreover, the pair of friction members are formed in different thicknesses, respectively, the thicker friction member is bonded to the inner surface of the disk body facing the wheel and the thinner friction member is bonded to the outer surface of the disk body. The thicker friction member bonded to the inner surface of the disk body on the side of the wheel is capable of absorbing a large amount of heat generated when a braking force is applied to the brake disk. Thus, the inner friction member facing the wheel and the outer friction member not facing the wheel can be maintained at substantially the same temperature. Consequently, is capable of absorbing a large amount of heat generated when a braking force is applied to the brake disk. Thus, the inner friction member facing the wheel and the outer friction member not facing the wheel are maintained at the same temperature. Consequently, both the friction coefficient associated with the inner friction member and the friction coefficient associated with the outer friction member can be held on a substantially fixed level.

[0063] In summary it is an object to provide techniques capable of forming a light brake disk and of suppressing the cost of the brake disk

To achieve this, a brake disk 30 has a disk body 35 formed of a titanium alloy, and inner and outer friction members 40, 42 formed of a stainless steel and bonded to the opposite surfaces 36a, 36b of the disk body 35 by a brazing method. The friction members 40, 42 can be simply bonded to the opposite surfaces 36a, 36b of the disk body 35 .

Claims

1. A brake disk comprising: a disk body (35) formed of a titanium alloy or an aluminum alloy; and friction members (40,42;62,64) formed of an iron-base material and bonded to opposite surfaces (36a,36b) of the disk body (35) by brazing.

2. A brake disk for a motorcycle (10), to be mounted on a hub (21) included in a wheel (20), said brake disk (30;60) comprising: a disk body (35) formed of a titanium alloy or an aluminum alloy; and friction members (40,42;62,64) formed of an iron-base material and bonded to the opposite surfaces (36a, 36b) of the disk body (35) by brazing; wherein the pair of friction members (40,42;62,64) have different thicknesses, respectively.

Fig. 1

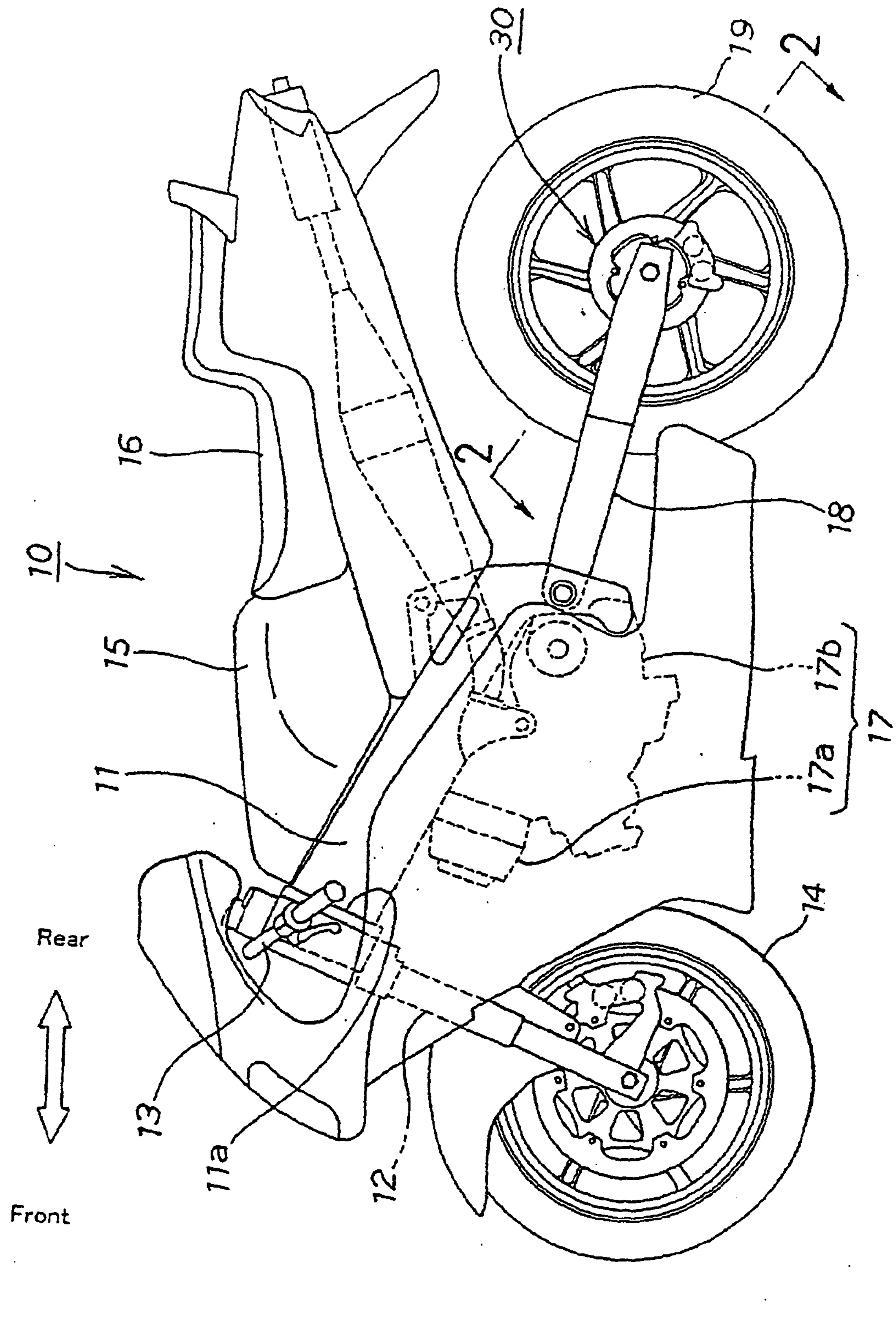


Fig. 2

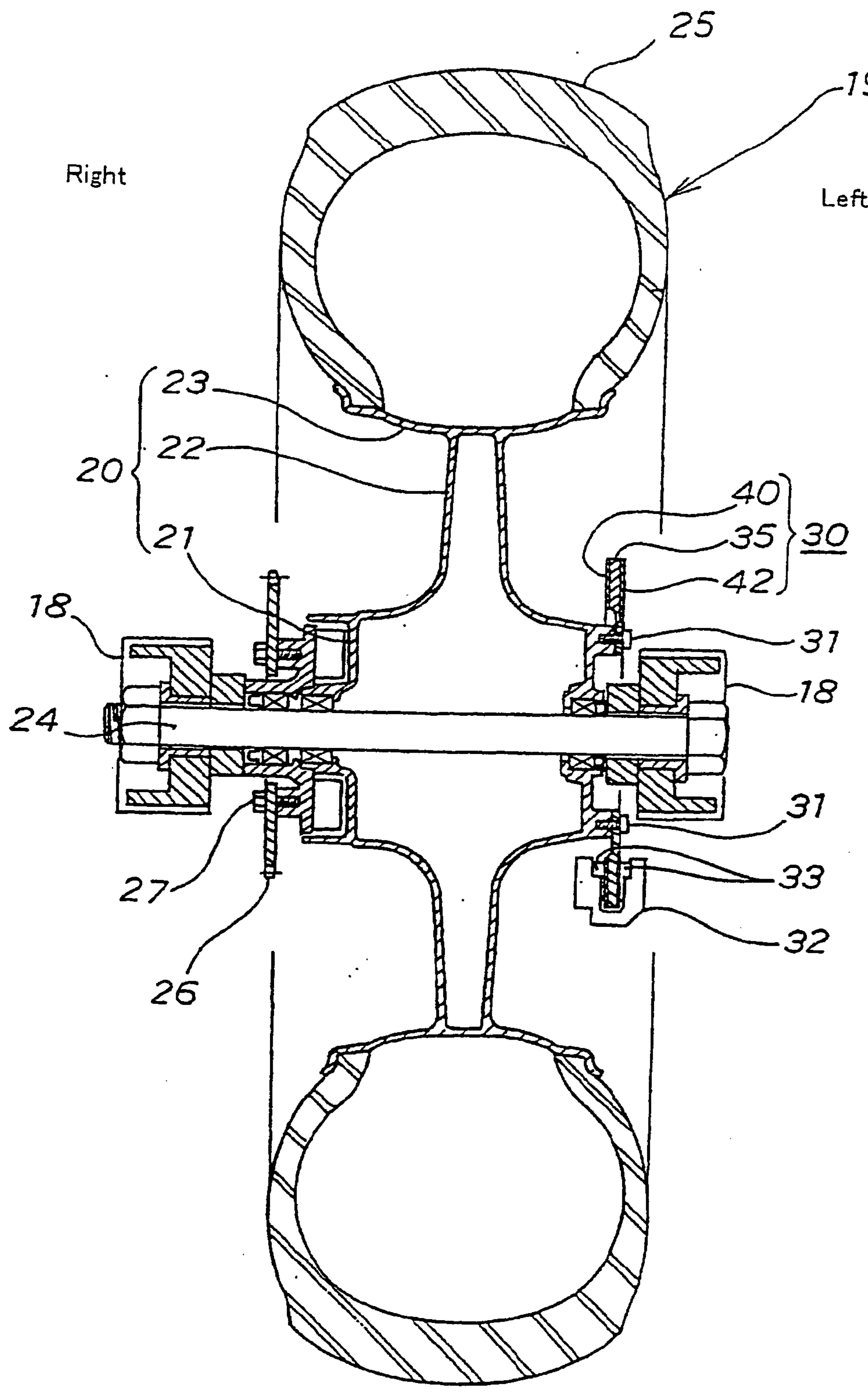


Fig. 3

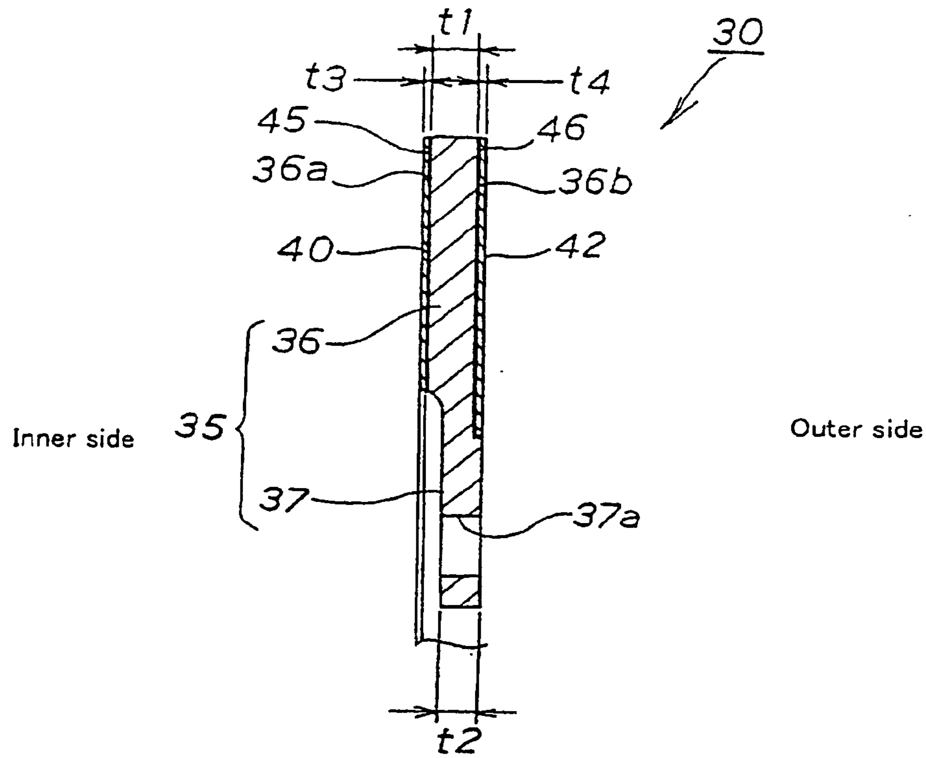

t1
30
t3
t4
45
46
36a
36b
40
42
36
35
Inner side
Outer side
37
37a
t2

Fig. 4

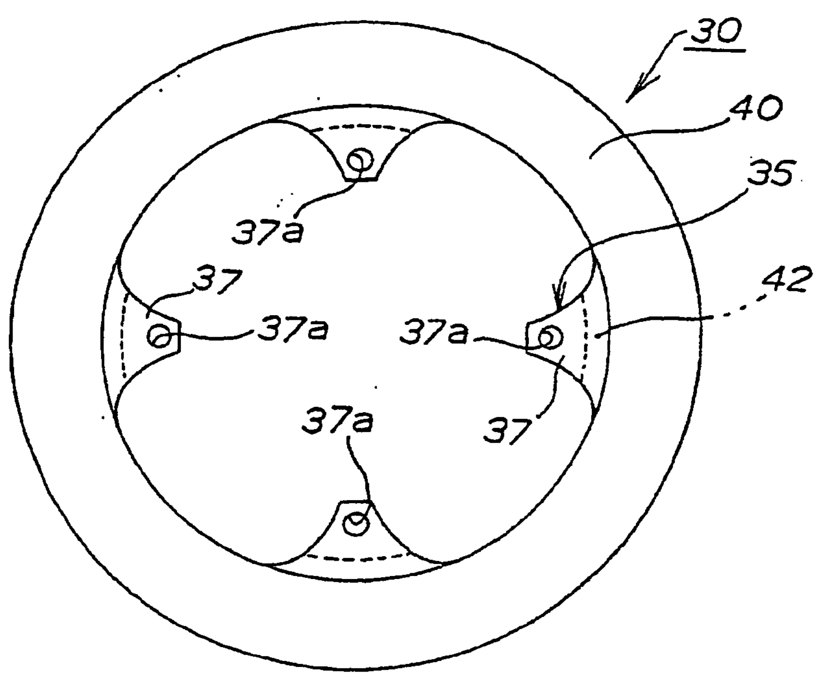

30
40
35
37a
37
42
37a
37a
37a
37

Fig. 5

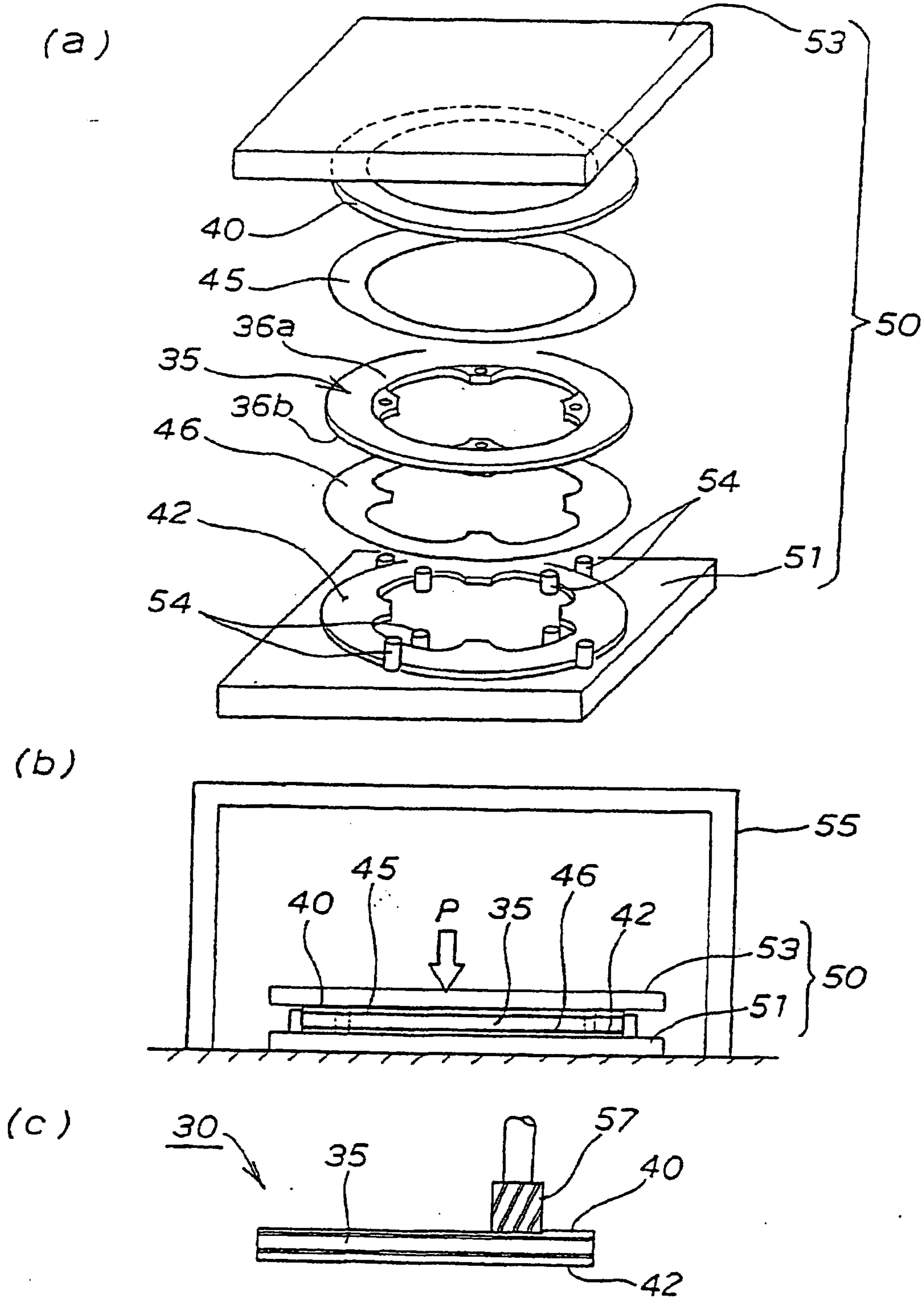

(a)
53
40
45
36a
35
36b
46
50
54
42
51
54
(b)
55
45
46
40
P
35
42
53
50
51
(c)
30
57
35
40
42

Fig. 6

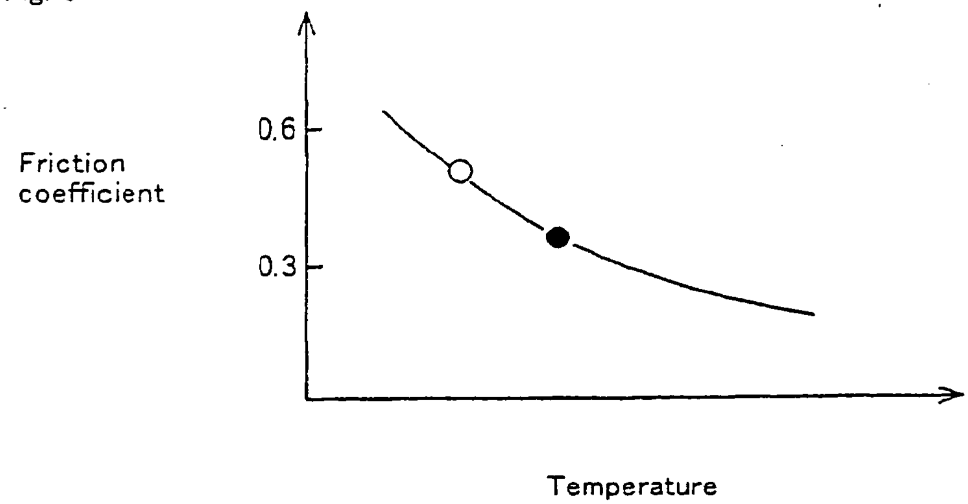

Friction
coefficient
0.6
0.3
Temperature

Fig. 7

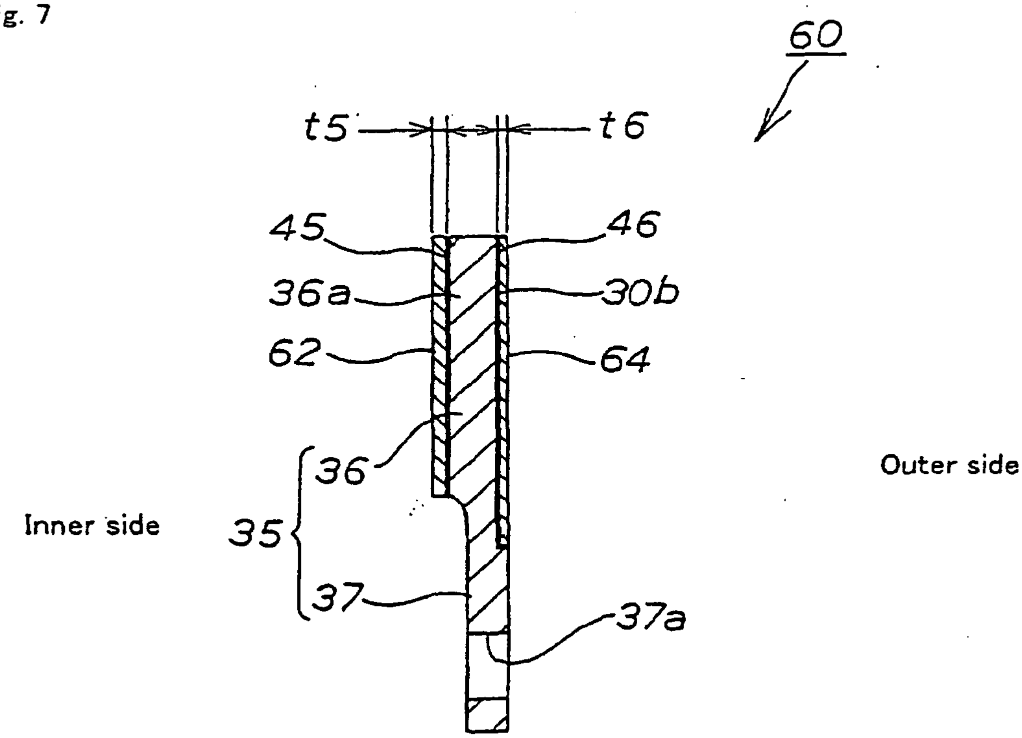
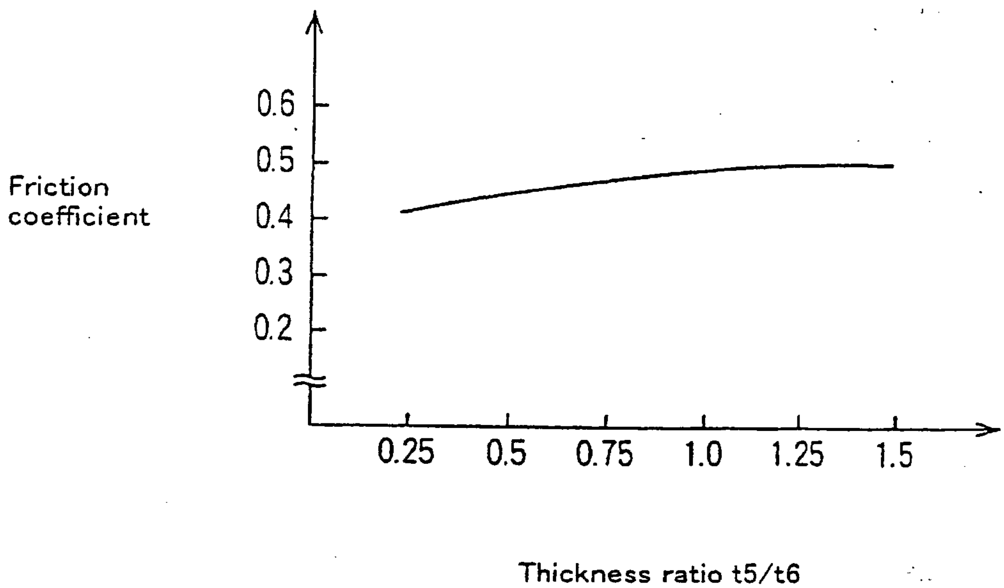

60
t5
t6
45
46
36a
30b
62
64
36
35
37
37a
Inner side
Outer side

Fig. 8


Friction
coefficient
0.6
0.5
0.4
0.3
0.2
0.25
0.5
0.75
1.0
1.25
1.5
Thickness ratio t5/t6

(19) Europäisches Patentamt
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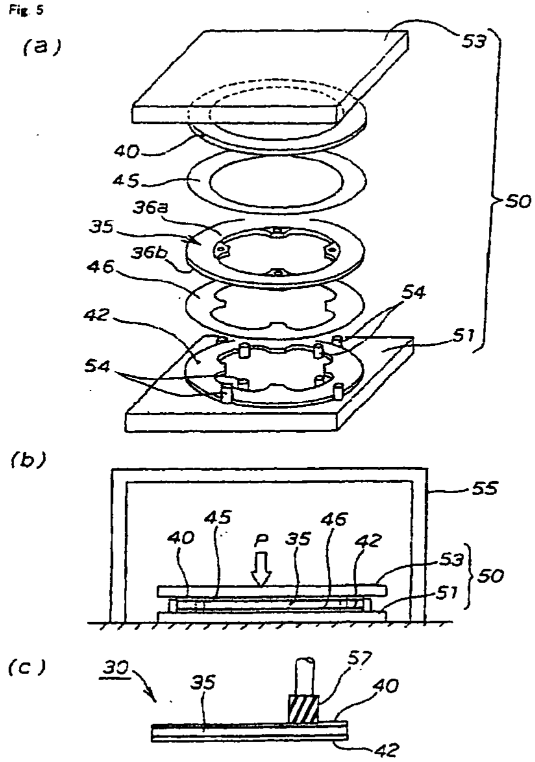
(54) **Brake disk composed from different metals and method for manufacturing the same**

(57) The invention provides techniques capable of forming a light brake disk and of suppressing the cost of the brake disk

A brake disk (30) has a disk body (35) formed of a titanium alloy, and inner and outer friction members (40, 42) formed of a stainless steel and bonded to the opposite surfaces (36a, 36b) of the disk body (35) by a brazing method. The friction members (40, 42) can be simply bonded to the opposite surfaces (36a, 36b) of the disk body (35).

Fig. 5



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EUROPEAN SEARCH REPORT

Application Number
EP 01 10 4154

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	DE 21 08 950 A (PORSCHE KG) 31 August 1972 (1972-08-31) * page 2, last paragraph * * page 4, last paragraph * * figures *	1,2	F16D65/12 F16D69/04
X	US 5 626 211 A (GEWELBER YTZHAK ET AL) 6 May 1997 (1997-05-06) * column 3, line 51 - column 4, line 34; figures 1-4 *	1,2	
A	PATENT ABSTRACTS OF JAPAN vol. 008, no. 166 (M-314), 2 August 1984 (1984-08-02) & JP 59 062738 A (YAMAHA HATSUDOKI KK), 10 April 1984 (1984-04-10) * abstract *	1,2	
A	PATENT ABSTRACTS OF JAPAN vol. 007, no. 189 (M-237), 18 August 1983 (1983-08-18) & JP 58 091936 A (YAMAHA HATSUDOKI KK), 1 June 1983 (1983-06-01) * abstract *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.7) F16D
A	GB 1 290 645 A (MESSIER) 27 September 1972 (1972-09-27) * page 1, line 86 - page 2, line 1; claims 5,12; figures 1,5,6 *	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	24 January 2002	Gertig, I

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
DE 2108950	A	31-08-1972	DE	2108950 A1	31-08-1972
US 5626211	A	06-05-1997	NONE		
JP 59062738	A	10-04-1984	JP	1507767 C	26-07-1989
			JP	63058296 B	15-11-1988
JP 58091936	A	01-06-1983	NONE		
GB 1290645	A	27-09-1972	FR	2108233 A5	19-05-1972
			FR	2095179 A6	11-02-1972
			CA	976892 A1	28-10-1975
			CH	528684 A	30-09-1972
			DE	2106290 A1	02-09-1971
			IL	36191 A	14-01-1974
			JP	53025904 B	29-07-1978
			SU	406378 A3	05-11-1973
			US	3895693 A	22-07-1975

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